

ment. We have two electrical keys, one at the further end intended for making what is called the signal, and one here for breaking, which is placed close to the person who is to be experimented upon. Mr. Page, at any moment he likes, will act upon me by sending an induction flash through my tongue. I shall arrange the electrodes so that they shall be against the tip of my tongue, and at the moment I feel that flash I shall place my finger on the key. Then the clockwork being in motion at the same time, we shall see by the length of the depression in the tracing the duration of the process. If we take different sorts of signals, or if the person to be experimented upon is in different conditions, the time will be very different. Thus we may compare the result which will be produced when I am attending and expecting the signal with the result which will be produced when I am not attending or expecting the signal; or, on the other hand, I may compare those results with that which will be produced when I am expecting it, but Mr. Page, instead of giving it at the time I expect it gives it me at a different time; in that case the time occupied would be longer than in either of the other two cases. A great variety of different cases can be investigated in this way in which we measure the total period occupied in the reflex. The arrangement is perfectly simple. You see when Mr. Page presses on his key, which is the signal key, that a lever is set in vibration and makes a tracing, and at the same moment the voltaic current is made and the coil is acted upon inductively; the result is that an induction flash passes through my tongue which I feel, and the moment I feel it I break the current. Consequently the time between the moment at which Mr. Page makes the current by closing his key and the moment at which I break the current by placing my finger on my key, gives us precisely the time which is occupied by the reflex process. We will make two experiments, first, with the signal expected, and then unexpected; that is, in the one case I shall be on the *qui vive*, and on the other I shall not be so. (The experiments were made accordingly.) We shall now repeat the process, so that instead of my receiving the information of the making of the current by means of the excitation of my tongue, the signal shall consist in my hearing the sound of an electrical bell. In that case we shall find that, although the signal will come in exactly the same way, practically the time occupied will be very considerably longer, showing that a signal received by sound takes longer in producing its effect than one in which the signal is felt by the tongue.

In order to make all this perfectly plain I shall hand round this tracing. You will see there several experiments made with expected and unexpected signals, which show the different results obtained in the two cases.

The next question which arises, and with that I must conclude what I have to say just now, is this:—You will readily see that the exact measurement of time depends upon the rate at which this clockwork happens to be going. I happen to know that it makes twenty revolutions per second. But suppose I do not know that. In fact one would not trust to the accuracy of clockwork for such a purpose. How should I then be able to measure the duration of time so exceedingly short as the one which now concerns us? In order to do this we always come back to a physical standard, to a standard of absolute invariability which we can depend upon as being true. For this purpose we use a tuning-fork which produces vibrations, the rate of which we know, because we know the tone which the tuning-fork produces, and the arrangement which is always used for this purpose is the one shown here. We have turned off the voltaic current we used for signalling, and turned it on the tuning-fork. There are two electro-magnets on either side of the tuning-fork which react upon it, so that the moment you close the current the fork is thrown into vibration and

produces its own characteristic note. All that we have to do is, during the time we are making our record, to bring this tuning-fork, which is now in vibration, into such a position that this little brass pointer shall make a tracing against the paper. If you look at the tracing I have sent round you will find there are tracings on it of a fork, which vibrates at the rate of 100 per second, consequently you have nothing to do but to translate the tracings which you have made and which correspond to the duration of the mental process which you have been investigating, into vibrations of the tuning-fork, and you get an exact measurement of the total duration of the process. While I have been doing this you hear the tuning-fork is in vibration, and Mr. Page has made the tracings. After it is varnished it will be sent round and you will see the tracing made by the fork over the traces corresponding to the different experiments we made just now.

I may observe that although the experiments made on that paper were made with myself, you find that the period occupied by the reflex is considerably longer than in the other which I sent round previously. But that one may very easily explain from the abnormal conditions under which the experiment has been made as regards myself.

I intended to go on from this subject to another mode of investigation, namely, to the very beautiful instruments which have been lately introduced for the purpose of measuring the finest differences of bulk in different organs, as for example, in the human arm, by which you can ascertain the condition of the circulation precisely by a very exact registering-measurement of the bulk of the arm;¹ but as there are several other gentlemen now ready to address you, I will defer that till this afternoon. I will now conclude what I have to say by asking you to listen to Dr. Hooker.

SCIENCE IN GERMANY

(From a German Correspondent.)

HERR v. OBERMAYER has recently communicated a memoir to the Vienna Academy on the relation of the coefficient of internal friction of gases to the temperature. If we accept for the coefficients of friction μ at $t^{\circ}\text{C.}$, the formula—

$$\mu = \mu_0(1 + at)^n$$

where a is the coefficient of expansion of the gas, taken as basis of the calculation, then the experiments of Obermayer give the following results:—

For Air	$n = 0.76$
„ Hydrogen	$n = 0.70$
„ Oxygen	$n = 0.80$
„ Carbonic oxide	$n = 0.74$
„ Ethylene	$n = 0.96$
„ Nitrogen	$n = 0.74$
„ Protoxide of nitrogen	$n = 0.93$
„ Carbonic acid	$n = 0.94$
„ Ethyl chloride	$n = 0.98$

The coefficient of friction of the permanent gases is, according to these experiments, approximately proportional to the $\frac{1}{2}$ -power of that of the coercible gases, and to the 1-power of the absolute temperature.

For temperatures between 150° and 300°C. , air gave the same values of n as between the lower temperatures $-21^{\circ}5$ and $53^{\circ}5$. In the case of carbonic acid a slow decrease of the exponent n with the temperature was perceptible from the experiments. W.

NOTES

ON Tuesday a visit was paid to the *Challenger* at Sheerness by several Fellows of the Royal Society, foreign men of Science, who are in London in connection with the Loan Collection

¹ The apparatus was fully described subsequently by Mr. Gaskell.

Conferences, and representatives of the Science and Art Department. Among those who made up the party were Lord Clarence Paget, Sir Henry Cole, Mr. Norman Macleod, Majors Donnelly and Festing, Mr. E. J. Reed, M.P., Professors Allman and Crum-Brown, Mr. Norman Lockyer, Professor Eccher, Baron von Wrangell, Dr. Biedermann, and others. Luncheon was served in the Ward-room, but as there was not sufficient accommodation for all the visitors many left by special train for Chatham, where luncheon had been provided in the Engineers' Mess-room. Invitations to visit the *Challenger* have been sent by the Admiralty to all the English and foreign members the Kensington Loan Apparatus Committee, many of whom have accepted them. The *Challenger* will be open to inspection to-morrow. The ship lies at present in the very spot she left when she set out on her cruise three and a half years ago, and to-day she is to be swung for the adjustment of her compasses and the taking of magnetic observations. It is thought that ten or twelve days will elapse before all the stores can be taken out to enable her to pay off.

FROM the official list of visitors to the Loan Collection during last week, which we give below, it will be seen that full advantage is being taken of the opportunity afforded:—

Monday	...	...	...	...	1,822
Tuesday	...	...	...	...	2,816
Wednesday	...	...	...	...	772
Thursday	...	...	...	...	891
Friday	...	...	...	...	939
Saturday	...	...	...	...	3,457
Total	...	...	...	...	10,697

DR. DONDERS, of Utrecht, and Prof. van Beneden, of Louvain, are two of the latest arrivals in connection with the Loan Collection Conferences.

It is proposed to hold an International Convention of Archaeologists, at Philadelphia during the Centennial, and in connection with the Centennial Exposition, for the purpose of promoting acquaintance and increasing the means of information in American Archaeology and Ethnology. The State Archaeological Society of Ohio will provide rooms for the Convention, and the first meeting will be held in the Ohio Building, at 2 o'clock, P.M., Sept. 4, 1876. The American Association for the Advancement of Science, meets at Buffalo, N. Y., Aug. 23, at which time a Subsection of Anthropology will be formed. The Convention has been appointed near the close of the session of the Association in order that those who desire may conveniently attend both meetings. Large collections, in Ethnology and Archaeology, from the Smithsonian Institution, the State Society of Ohio, and other public and private sources will be on exhibition, and will furnish a great incentive for Archaeologists to visit the Exposition. The meeting of this Convention at Philadelphia, must be regarded on that account as very opportune, and a large attendance is expected. Addresses from prominent anthropologists will be delivered, and it is hoped that a great impetus to investigations in America will be gained. Archaeologists who purpose to attend are requested to bring any articles or illustrations which they may have, as the opportunity for a temporary exhibition will be given. The Chairman of the Ohio Committee is the Rev. S. D. Peet, of Ashtabula, O. European men of science who intend to be present at the Buffalo meeting of the American Association, should write to Prof. F. W. Putnam, Salem, Mass., who might be able to make arrangements, by which their expenses would be kept down.

IN connection with the great International Exhibition at Philadelphia, it is interesting to note that that city is one of the healthiest in the world, so far as the death-rate is a test. In

1874, according to an official circular just issued, with a population of 775,000, the death-rate was only 19·3 per thousand. This very favourable result is largely due to the abundant and cheap water-supply, and to the opportunities given, even to the poorest citizens, for the enjoyment of pure country air in the great Fairmount Park, which contains 2,991 acres. The most powerful influence of all, however, is the absence of that overcrowding of the population, which is the most fruitful source of sickness and death in many quarters of nearly all other large cities. This will be more clearly comprehended when it is remembered that the 817,488 inhabitants of Philadelphia are spread over an area of 129½ square miles, which are traversed by more than one thousand miles of streets and roads. The climate of Philadelphia is also, on the whole, a favourable one, although presenting many of the peculiarities common to inland localities. The mean annual temperature of the last ten years is 53·73° Fahrenheit; the average annual rain-fall is about forty-five inches.

THE *Conversazione* of the President of the Institution of Civil Engineers takes place to-night in the South Kensington Museum itself, instead of in the Galleries devoted to the Scientific Apparatus Exhibition, as was at first intimated.

WE are informed that the new Zoological Gardens of Calcutta will be opened on the 6th of this month, and that Mr. J. C. Parker has been appointed temporary Curator of the establishment. There is a fine show of Indian Ruminants and other ordinary Indian animals; a splendid pair of the Himalayan Bears (*Ursus tibetanus*), and likewise examples of the other Indian species, *Ursus labiatus*, *U. malayanus*, and *U. isabellinus*. Among the rarities is a cage full of the Indian Tupaia (*Tupaia ellioti*), a curious insectivorous form, of which the Zoological Society of London had living examples not long since.

THE *Pandora* left Portsmouth on Saturday on her voyage to the Arctic Regions. One of her main objects is to take out letters, papers, &c., for the officers and crews of the *Alert* and *Discovery*; these will be deposited in certain dépôts on the chance of Capt. Nares being able to communicate with the entrance to Smith's Sound. The *Pandora* takes out a very considerable number of letters and packets of various kinds, and not the least interesting news to Capt. Nares will be that of the successful conclusion of the *Challenger* Expedition. It is generally understood that, after depositing his mail, Capt. Young will make another attempt to push his ship through Peel Straits, or Bellot Straits, and Franklin Channel, and so on into Behring Straits, and thus be the first to make the North-west Passage by sea.

It is encouraging to find our legislators and "leaders of industry" enlightened enough to realise and plainly state the condition of this country with regard to scientific education. The place which this country at present holds in the matter of scientific industry, as contrasted with Continental countries and with America, has been frequently referred to of late both by public men and in these columns. The case was again briefly but pointedly stated by Mr. Samuel Morley, M.P., on Monday, at the Annual Meeting of the Artisans' Institute. "It was," he said, "essential that our sons of toil should become humble disciples of science if England was to keep pace with foreign nations in the excellence of her manufactures. The competition of industry was rapidly becoming a competition of intellect; and Belgium, Germany, and America were fast treading upon our heels in the quality of their manufactures. Seeing that at no period for thirty years had there been so widespread a depression in trade as at present, he thought the great importance of imparting scientific instruction, with a view to the maintenance of our position, would be sufficiently obvious to all. Unless this was brought to bear upon our manufactures, the situation of this

country would be one of great peril, and he sincerely hoped that the advantages offered to the working classes would be thoroughly appreciated by those whom the organisation was intended to benefit." We hope that sentiments like these will have due weight in the framing of our Education Codes.

We are glad to hear that the Duke of Cleveland has directed the Shropshire meteorite to be placed at the disposal of the authorities of the British Museum.

IN October next, we learn from the *Western Daily Press*, the Bristol University College will be an accomplished fact. Professors of Chemistry and of Modern History, and Literature are to be appointed for the opening of the first session and Lectures delivered on the following subjects:—Mathematics and Applied Mechanics, Experimental Physics, Political Economy, and Classical History and Literature. It is gratifying to find that public spirit in Bristol has not only not allowed a great opportunity to pass, but has brought the College into existence, as a working institution, with praiseworthy rapidity. The council has appointed Mr. F. N. Budd as chairman, Mr. W. Proctor Baker as treasurer, and Mr. Edward Stock, secretary.

B. C. DUMORTIER'S "Hepaticæ Europæ," published by C. Muquardt of Brussels, is the only work which gives a complete account of the Hepaticæ or Liverworts of Europe, and embraces the work of more than fifty years of a veteran botanist. For a limited period, until July 1, the work is offered at a reduced price of 5fr., after which the published price will be 8fr. It is illustrated with four coloured plates.

BY authority of M. Waddington, the older pupils of the National School of Agriculture, established at Grignon, in France, left, on May 25, for the Netherlands, where, with their professors, they are to make an agricultural tour which is to last for three months. It is stated that they will come to England next year. Grignon was the first agricultural school established in France, and was purchased by the Government many years ago. The course of studies is for three years.

DR. LELORRAIN, a *licencié* in natural science, has just organised a series of scientific excursions in the vicinity of Paris. They are to take place each Sunday during the months of June, July, and August. The excursionists will receive practical instruction in geology, botany, and entomology, by competent teachers.

ON Monday June 26, an extraordinary session of the French Botanical Society will be held at Lyons. A number of botanists from Belgium and Switzerland will join the Society, and an important botanical exploration will be made. English botanists will be very heartily received. Particulars may be obtained by directing letters to the General Secretary, 84, rue de Grenelle, St. Germain, Paris.

THE eighth session of the International Anthropological and Archeological Society will be held at Buda-Pesth, under the presidency of M. Francois Pulszky, General Inspector of the Public Libraries in Hungary. The General Secretary of the Buda-Pesth Congress is M. Florian Romer. An English committee will be appointed.

WE are glad to see that a second edition of Mr. W. N. Hartley's "Air and its Relations to Life," has been published by Messrs. Longman and Co. In this edition Prof. Tyndall's recent experiments are described.

WE have received Dr. C. Bruhn's monthly reports of the meteorological observations made at twenty-four stations in Saxony during 1875. To the reports which briefly summarise the results for each month is appended an interesting *résumé*,

pointing attention to the more striking features of the weather during the year, and comparing these with the results of previous years' observations, and giving the annual means and extremes of all the meteorological elements at each station, together with the dates of occurrence of several interesting phenomena, such as the day of heaviest rainfall, of greatest dryness of the air, and the latest and earliest frost and snow.

IN the *Bulletin International* of the Paris Observatory of May 17 to 19, there appears an important paper by M. Belgrand, on the means of protecting Paris from the inundations of the Seine. The great flood of March 17 last marked 107½ feet on the river-gauge at the bridge of Tournelle, which is three feet less than the height to which the great flood of Jan. 3, 1802, rose, and 7½ feet less than that of Feb. 27, 1658, the greatest flood on record. With a view of protecting the parts of the city liable to suffer from such floods, M. Belgrand proposes to prolong the main drains and the embankments down the river as far as the fortifications, to isolate them completely from the river, and to keep them, by means of machinery, at their normal level. Further, to prevent the flooding of cellars, he proposes a system of drainage at a lower level than that of the cellars liable to be flooded, and having no communication with the river and the main drains, these drains to be kept at the proper level by centrifugal pumps and turbines driven by the water of the city.

WE have received the first part of the first vol. of a "Handbuch der Palæontologie," by Profs. Schimper and Zittel. It is published at Munich, by R. Oldenbourg.

MR. W. DITTMAR has just published (Edmonston and Douglas) a collection of useful Tables as an Appendix to his "Manual of Qualitative Chemical Analysis," which we recently noticed.

"ESSAY on the Use of the Spleen, with an Episode of the Spleen's Marriage, a Physiological Love-story," is the title of rather an original little work just published by Dr. Patrick Black (Smith, Elder, and Co.).

AS Supplement 47 to Petermann's *Mittheilungen*, has been published an account of Herr G. A. Hagenmacher's Travels in Somali Land. The author gives a systematic account of his observations in this region of Africa, under the headings of Narrative of the Journey, Physical Geography, Ethnography and Ethnology, Agriculture and Cattle-breeding, Industries and Trade, and a History of the Somalis.

THE latest additions to the Royal Westminster Aquarium include the following:—Hawksbill Turtles (*Caretta imbricata*), from the West Indies; Picked Dogfish (*Acanthias vulgaris*), and Lesser Spotted Dogfish (*Scyllium canicula*), presented by the Yarmouth Aquarium Society; Armed Bullheads (*Agonus cataphractus*), Greater Pipefish (*Syngnathus acus*), Sea Horses (*Hippocampus ramulosus* et *brevirostris*), Venus's Ear-shells (*Haliotis tuberculata*), from Guernsey; Sea Mice (*Aphrodite aculeata*), Purple Urchins (*Echinus lividus*), Sun Starfish (*Solaster papposa*), Mediterranean Corals (*Balanophyllia verrucaria*), Venus's Flower-basket Sponge (*Euplectella aspergillum*), from the island of Zebu, Collected and presented by Capt. W. Chimmo, R.N.

THE additions to the Zoological Society's Gardens during the past week include a Silver Pheasant (*Euplocamus nychthemerus*) from China, presented by Mr. W. Miles; a Common Barn Owl (*Strix flammea*), European, presented by Mrs. Knight; a Blue-faced Amazon (*Chrysotis amazonica*) from South America, presented by Miss M. Jukes; a Silky Marmoset (*Midas rosalia*), a Huanaco (*Lama huanacos*), an Azaras Fox (*Canis azaras*), three Chinchillas (*Chinchilla lanigera*) from South America, deposited.